Feature

Ultrasonics in Periodontal Therapy — The Paradigm Has Changed

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Introduction

Ultrasonics has traditionally had an adjunctive role in periodontal therapy. The size and shape of ultrasonic tips has created this limited usage. With modification of ultrasonic tips to more closely resemble periodontal probes, their application in manually-controlled ultrasonic units have shown many advantages over hand instrumentation. Consequently, modified ultrasonic tips should now be considered to have a primary role in root debridement.

History

Ultrasonics was first utilized in dentistry for cavity preparation in the 1950's. An abrasive slurry was used as part of this technique, which created a visibility problem. The air turbine handpiece was being developed during this same time and its advantages made the use of ultrasonics in restorative dentistry rather short lived.

In 1955, Ewen wrote the first textbook *Ultrasonic Therapy In Periodontics*. This book described ultrasonic usage ranging from rootplaning and curettage to periodontal surgery, which included gingivoplasty, gingivectomy and mucogingival surgery (1).

Ultrasonic Physics

Ultrasonics is the conversion of electrical energy into mechanical energy (vibrations). A generator produces a high-frequency electrical current that is passed through a transducer. The transducer is either magnetostrictive or piezoelectric.

In 1958, Dentsply/Cavitron started producing ultrasonic scalers using the magnetostrictive principle. This unit had manual controls for power, tuning and water flow. It has a frequency of 24,000 cycles/second. The piezoelectric unit has a frequency of 42,000 cycles/second. Sonic scalers convert compressed air into a vibrating working tip that has 2,500 - 7,000 cycles per second range.

Dental Textbooks

Most textbooks on periodontics devote a chapter to root planing. Authors usually go into great detail about curettes and the use of each curette (i.e., proper angle of working edge, fulcrum points, finger position, etc.). Perhaps one or two paragraphs in the chapter will mention the use of ultrasonics in an adjunctive role. This role is the result of the standard tip size which limits its use for only supragingival calculus and stain removal (2, 3). However, we are now starting to see some textbooks recommending ultrasonics as a primary means of providing root debridement (4, 5, 6). This is a result of modifying the tip's size and shape.

Traditional Concerns

The limited use of ultrasonics in periodontal therapy had several reasons. Besides the size and shape of the tips, which prohibited an appreciable penetration subgingivally, there was concern about the gouging of root surfaces. It was also felt that there was loss of the tactile sense of the operator.

It must be remembered that for decades, the *sine qua non* in restoring a periodontally diseased dentition to health was smooth, glassy-like root surfaces. These root surfaces were to be devoid of any calculus and most of the cementum was removed in an effort to remove the endotoxin. It was postulated that a smoother root surface would provide less chance for the accumulation of bacterial plaque (7).

Root Smoothness

A review of the dental literature will reveal articles showing smoother root surfaces with the use of ultrasonics when compared to hand instruments (8,9) and vice versa (10,11,12). The most recent research using a modified P10 tip in a manually adjustable ultrasonic unit (Dentsply 660) produced a smoother root surface than hand instruments (13).

Debridement

Hatfield and Baumhammers showed that periodontally involved

roots created irreversible morphologic changes when placed in tissue cultures that healthy roots did not (14). Aleo et al., using limulus lysate assay for endotoxin, showed that periodontally involved root surfaces depressed the growth of fibroblasts (15). Several articles were then published showing that thorough root planing of the periodontally-diseased roots rendered them free of endotoxin and compatible with attachment of gingival fibroblasts (16,17).

Although earlier studies of Nishmine et al. and Checchi et al. have differed on the amount of endotoxin removed by hand instrumentation versus ultrasonics, both methods rendered root surfaces compatible to fibroblast attachment (18,19).

More recent studies of Smart et al. and Chiew et al. demonstrated findings in regard to the depth of penetration of the endotoxin. Both studies used ultrasonics with TF 10 tips and light, overlapping strokes. This technique reduced the endotoxin to the level of healthy, control teeth (20,21). Smart's study used periodontally diseased teeth with no clinically detectable calculus. Chiew's study was very similar, but used only periodontally diseased teeth with extensive amounts of calculus present on the roots. The same technique used TF10 tips with light, overlapping strokes concentrating to completely cover the root surface without reference to the presence of calculus. There was marked reduction of the calculus, but some calculus remained. The remaining calculus did not stop a dramatic change in the endotoxin level from 1,900-29,200 ng in noninstrumented teeth to .08-22.4 ng in instrumented teeth.

Cavitational activity occurs within the water as it hits the ultrasonic oscillating tip. This produces hydrodynamic shear stresses close to the oscillating objects. Walmsley, using *in vitro* studies, has suggested that the hydrodynamic forces create a larger area of plaque removal than the ultrasonic tip without any water being used (22,23,24).

The dental literature is replete with articles showing that complete removal of subgingival calculus and plaque is difficult to achieve (25-31). However, in spite of this, oral hygiene, scaling and root planing have been shown to be effective in treating periodontal disease, particularly when the pocket depths are in the 5-mm range (32-36). Our ultimate goal is to reduce all etiologic factors (i.e., calculus, plaque and endotoxin) to a threshold that results in the patient controlling the infectious process, thereby improving the clinical signs of inflammation (37).

Microbiology

Oosterwaal showed that hand instruments and ultrasonics using a TF 10 tip reduced the subgingival microbiota equally comparing microscopic and culture techniques on single-rooted teeth (33). However, Leon and Vogel found a greater reduction in the microbiota in Class II and Class III furcations when ultrasonics were used (39). Thilo demonstrated that ultrasonification of subgingival plaque resulted in a decrease in motile rods and spirochetes (40).

Dental Anatomy and Instrument Design

Bower measured the entrance width of maxillary and mandibular first molars and compared that to the widths of the three most commonly used curettes (41). The curettes measured 0.75-1.10 mm. When compared to the entrances of the maxillary molar furcations, 58% of the entrances were smaller than the curette blade width. The buccal furcations were smaller than the mesial and distal furcations in the maxillary molars. The buccal furcations were smaller than the lingual furcations on mandibular molars. Chiu et al. measured the furcation widths of first molars, curettes and Dentsply TF 10 tips (42). The curettes measured 0.75-1.0 mm and the TF 10 tips 0.61 mm. They found in the maxillary first molars that 79% of buccal entrances, 39% of the mesial entrances and 43% of the distal entrances were smaller than the 0.75-mm blade width of a new Gracey curette. In the mandibular first molars, they found that 36% and 47% of the buccal and lingual furcation entrances, respectively, to be less than the 0.75-mm blade widths. Hou et al. did a similar study, but this study included second molars (43). The maxillary second molars had 83%, 43% and 65% of cases, respectively, of the buccal, mesial and distal furcations with less width than the width of the curette. The buccal and lingual furcations were 63% and 61% smaller, respectively. Thus, second molar furcations are even more difficult or impossible to debride with a curette.

Even if a curette is small enough to enter the furcation, it is extremely difficult to position the working edge of the curette and then activate it so as to be effective in debriding the furcation. O'Leary states that instrumentation of the tooth and its root surfaces is the most common procedure carried out in the dental office and is vital to the maintenance of periodontal health. However, it is one of the most difficult techniques to master (44). Many factors that prohibit good root debridement, such as anatomy of roots, depth of pockets, position of teeth, size of mouth, range of opening, etc., cannot be altered. Tom Holbrook, a periodontist in Florida, realized many of these same limitations and over 25 years ago started reshaping cavitron tips (Figure 1) to more closely approximate the size and shape of the periodontal probes used in a periodontal examination. He developed a technique using these small tips in a manually-adjusted Cavitron.

Technique

The use of modified P10 tips bears

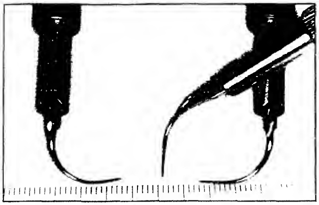

Figure 1. Modified Cavitron tips, according to Holbrook. The tips are designed to more closely approximate the size and shape of periodontal probes.

little similarity to the technique used with curettes (4,5). A light pen grasp is used, rather than the firm, modified-pen grasp, for curettes. The idea of a hard- tissue finger rest and a fulcrum to work around is contraindicated for the modified P10 tip. A gentle, soft-tissue rest is used, which allows the tip to move slowly into the pocket, thus determining the gingival attachment and topography of the pocket. A rapid brushing stroke that completely covers all of the root surfaces of the pocket is employed. Any attempt to try to work the tip against the root like a curette will dampen the tip and render it less effective, as well as create sensitivity for the patient.

The loss of tactile sense is not experienced. When the tip which approximates the size of a periodontal probe is inactivated, its end can give a good tactile sense. You lose this tactile sense with a curette due to its size, and the constriction placed on modified P10 tips is much less fatiguing. This has the potential of reducing or eliminating carpal tunnel syndrome.

Equipment

Holbrook and Low recommend ultrasonic equipment that is magnetostrictive, which has manual tuning and is compatible for use with Dentsply/ Cavitron inserts (4,5). An elliptical motion is created with this equipment that allows all surfaces of the tip to be used in debridement. Piezoelectric units create a linear motion that limits the tips to two surfaces of usage. Automatic, tuned Cavitron units limit the ability to control frequency (tuning), amplitude (power) and water flow and are not recommended for this technique. Sensitivity is very seldom a problem because you can manually adjust your frequency and power. Local anesthesia is seldom used.

Conclusion

Dragoo studied the effectiveness of hand instruments and ultrasonic tips, both modified and unmodified, on subgingival debridement (4,6). The results of this study suggested that the modified ultrasonic tips were the best instruments for scaling and root planning, since this technique was (1) easiest to learn, (2) easiest to teach, (3) most efficient in removing subgingival irritants, (4) least damaging to the root, (5) most effective in approaching the bottom of the pocket, and (6) least fatiguing for the operator. Patients readily accept this new technique and how gentle it is when compared to hand instrumentation. Research and patient response to the use of ultrasonics with modified tips is rapidly advancing its use in periodontal therapy.

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